

PASSIVE COMPENSATION OF FOCUS  
TRACKING UTILIZING WINDING AND CAPACITOR

Cross Reference to Related Applications

5           This is a non-provisional application which claims the benefit of provisional application serial number 60/373,876, filed April 19, 2002.

Background of the Invention

          This invention relates to high voltage transformers for video display apparatus and, in particular, to high voltage transformers that utilize a tertiary winding to generate a  
10 focus voltage.

          The electron gun assembly of a color cathode ray tube produces one or more electron beams which impinge upon a phosphor display screen in a predetermined pattern to form a scanned raster. The electron gun assembly is designed to produce a number of spatial regions of different voltage potentials through which the electron beam or beams pass. One of these  
15 voltage potential regions provide focusing of the beams so that the spots formed when the beams strike the display screen are of a desirable size and sharpness.

          The focus voltage or potential may be generated by providing a tap on the high voltage or tertiary winding of the high voltage transformer. The electron gun assembly used in one prior art utilizes a high voltage winding tapped to provide a focus voltage nominally equal to  
20 one-third of the high voltage or ultor potential. Changes in electron beam current, due to variations in picture brightness, may require that the focus ratio (i.e., the ratio of the focus voltage level to the high voltage level) remain constant regardless of the loading on the high voltage winding. As the electron beam current increases, however, the loading on the high voltage supply also increases, which may cause the high voltage level to decrease, resulting in  
25 an increase in the focus ratio. Some picture tubes incorporate an electron gun assembly that, in order to produce optimally focused beams, require the focus ratio to remain constant as beam current increases.

Summary of the Invention

          A focus voltage generator, embodying an inventive feature, in a video display  
30 apparatus having a cathode ray tube includes a high voltage transformer including a first winding, a focus winding, a high voltage winding and a tracking winding. The tracking winding is disposed closer to the focus winding than to the high voltage winding to provide a tighter magnetic coupling to the focus winding than to the high voltage winding. A

semiconductor switch is responsive to a periodic signal and coupled to a resonant circuit that includes the first winding for generating resonant pulses in the first winding. The resonant pulses are transformer coupled to the high voltage winding to generate an ultor voltage at an ultor voltage electrode of the cathode ray tube and is transformer coupled to the focus winding to generate a focus voltage at a focus electrode of the cathode ray tube. A capacitance is coupled to the tracking winding to generate from the resonant pulses a current in the capacitance and in the tracking winding that selects a mode of tracking between the focus and ultor voltages, as a function of a beam current in the cathode ray tube.

#### Brief Description of the Drawings

FIGURE 1 is a cross-sectional view of a high voltage transformer in accordance with an aspect of the present invention;

FIGURE 2 is a schematic and block diagram of a portion of a video display apparatus that includes the transformer of FIGURE 1; and

FIGURE 3 is a graph illustrating a relationship inherent in the operation of the transformer shown in FIGURE 1.

#### Description of the Preferred Embodiments

Referring to FIGURE 2, there is shown a portion of a video display apparatus including a cathode ray tube or picture tube 10 and a high voltage transformer 11 having a winding structure shown in FIGURE 1. Video signals illustratively received via antenna 8 of FIGURE 2 are applied to video processing circuitry 9, which demodulates and decodes the signal in an appropriate manner for application to video drive circuit 13. The output of video drive circuit 13 is applied to picture tube 10, which incorporates an electron gun assembly 12. Electron gun assembly 12, when energized, may illustratively produce three electron beams. Various operating voltage levels may be applied to electron gun assembly 12, including a focus voltage via a terminal 14. The electron beams are deflected to form a scanned raster by deflection yoke 15.

A source of AC voltage 16 is coupled to a rectifying circuit 17 which produces an unregulated DC voltage level that is applied to a regulator 20. Regulator 20 may illustratively be of various types, such as switched-mode regulators. An end terminal 23a of a primary winding 21 of a high voltage transformer 11 is coupled in common with a collector of a switching, output transistor 22 and with an end terminal of a tracking winding 23. An output of regulator 20 is coupled in common with the other one terminal of primary winding 21. The base of output transistor 22 is responsive to a control signal HSYNC produced in a

conventional driver stage, not shown. Control signal HSYNC is selectively provided at either 2H horizontal frequency having a period  $T_{2H}$  or at 2.14H horizontal frequency having a period  $T_{2.14H}$ . The term H refers to the horizontal frequency of a standard. For example, the value of H in the United States television broadcasting standard, NTSC, is 15.75 KHz. The frequency of signal HSYNC is an integer multiple of a frequency of a horizontal deflection current, not shown, in a horizontal deflection winding 15. The collector of transistor 22 is coupled to a damper diode 70 and to a flyback capacitor 71, in a conventional manner.

High voltage transformer 11 includes a high voltage winding 24, comprising three winding segments: a focus winding 42, an extension, high voltage winding 64 and an extension, high voltage winding 65. Rectifying diodes 61 and 63 are included between the corresponding windings. Windings 42, 64 and 65 are energized by pulses produced in primary winding 21, during the horizontal retrace interval. An ultor or a high voltage HV is applied from a terminal of winding 65 to an anode or ultor terminal of picture tube 10 via a conductor 25. A tap 27 on high voltage winding 24 provides a focus voltage FV that is applied to electron gun assembly 12 via terminal 14. Tap 27 is selected so that the voltage at tap 27 is nominally of the order of one-third the level of high voltage HV. The focus voltage generating portion of high voltage winding 24 will therefore comprise one-third of the full traverse of high voltage winding 24; i.e., one-third of the total number of winding turns of high voltage winding 24. The focus voltage is supplied from tap 27 to terminal 14 via a potentiometer 30. The other two-third of the total number of winding turns of high voltage winding 24 form high voltage windings 64 and 65 that contribute to high voltage HV significantly more than to focus voltage FV.

Tracking winding 23 of transformer 11, embodying an inventive feature, is coupled between the collector of transistor 22 and a terminal 23b of a tracking capacitor 72. Capacitor 72 is coupled between tracking winding 23 and a common potential or ground. A loading current  $i_{72}$  flows in a current path that includes capacitor 72 and winding 23.

FIGURE 3 shows the effect of various values of tracking capacitor 72 on a ratio FV/HV between focus voltage FV and high voltage HV as a function of a beam current  $i_{Beam}$ . Similar symbols and numeral in FIGURES 2 and 3 indicate similar items or functions. A magnitude of current  $i_{72}$  of FIGURE 3 that is determined by the value of capacitor 72 of FIGURE 2 establishes the degree of compensation. The appropriate choice results in an optimized curve of FIGURE 3 having, for example, the flattest response and is associated with a value of 1000 pf of capacitor 72 of FIGURE 2.

FIGURE 1. shows a cross section of high voltage transformer 11. Similar symbols and numeral in FIGURES 1, 2 and 3 indicate similar items or functions.

In FIGURE 1, the cross section shows a segment A of primary winding 21 and a segment B of primary winding 21 that, together, overlap high voltage windings 65 and 64 and focus winding 42. Slots 24a are used for holding in place high voltage windings 64 and 65 and slots 42a are used for holding in place focus winding 42. Tracking winding 23 is wound such that it forms an extension of primary winding 21 and is wound back under focus winding 42 forming a focus section of high voltage winding 24. The close proximity of focus tracking winding 23 to the turns of focus winding 42 allows sufficient coupling to modify the variation of the ratio between voltages FV and HV as a function of beam current  $i_{beam}$ . The selection of the ratio is obtained by selecting the value of capacitor 72 that determines current  $i_{72}$  in capacitor 72 in a manner to load focus winding 42.

In carrying out another inventive feature, end terminal 23b of focus tracking winding 23 that is closer to capacitor 72 is at a lower potential, with respect to ground than end terminal 23a of focus tracking winding 23 that is closer to the collector of output transistor 22. Thereby, advantageously, a higher voltage on capacitor 72 is avoided to prevent an increase voltage stress in an insulation between the windings of transformer 11.